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Vegetation Survey of Kosrae, Federated States of Micronesia

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Cover: The mangrove forest type is unique in its ability to grow in salt water.

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INTRODUCTION

Kosrae is one of the four States of the Federated States of Micronesia, eastern Caroline Islands. Knowledge of the extent and composition of vegetative areas, including forest land, is needed for land-use planning. To fill this need, a formal agreement was drawn up between the High Commissioner of the U.S. Trust Territory of the Pacific Islands and two agencies of the U.S. Department of Agriculture—the Soil Conservation Service and the Forest Service, to map the vegetation of Kosrae. The map was prepared by the Forest Service in cooperation with the Government of Kosrae State, and is intended to serve as a working tool for land-use planning and forest resource management, and to provide a basis for timber volume surveys.

This bulletin presents the vegetation map of Kosrae (see map in back pocket) and describes the different vegetation types, their ecological function, and uses. A detailed breakdown of nonforest types is also provided.

GEOGRAPHY AND CLIMATE

Kosrae is a heavily forested, volcanic island located at the eastern end of the Caroline Island group in the central Pacific Ocean (lat. 5° 19' N. and long. 163° 00' E.) (*fig. 1*). It lies about

500 km (300 statute mi) north of the equator and about 4501 km (2813 statute mi) southwest of Honolulu. The island is roughly triangular, with an area of about 11,186 ha (27,642 acres).

The interior of the island is characterized by relatively high, steep, rugged mountains covered with dense, lush vegetation that tends to change in species composition as elevation increases. Several mountain peaks rise to 600 m (1970 ft) above sea level, and Mt. Finkol is about 629 m (2064 ft) above sea level. Mountainous areas make up about 70 percent of the island, with foot slopes, alluvial fans, and bottom lands comprising about 15 percent of the total area. Approximately 14 percent of Kosrae Island is vegetated by mangrove swamps, and only 3 percent of the land area is classified as nonforest.

Subsistence farming and copra production are the main agricultural enterprises. The main subsistence crops are bananas, breadfruit, citrus fruit, coconuts, and taro. Scientists with the Soil Conservation Service have mapped and described 14 soil series on Kosrae and provided guidelines for farmers, land managers, developers, and others (Laird 1983).

The climate of Kosrae is characterized by high temperatures, heavy rainfall, and high humidity. The average annual rainfall measured at the Kosrae weather station in Lelu is 5000 mm (200 inches). The rainfall in the interior of the island has not been measured but is estimated to be as high as 7500 mm (300 inches) annually in these mountainous regions. The average annual temperature is 27 °C (81 °F) at sea level and is slightly lower at higher elevations. Average monthly temperatures vary from the annual average by not more than 1 °C, and the difference between the average minimum and the average maximum temperature is less than 8 °C (14 °F) throughout the year.

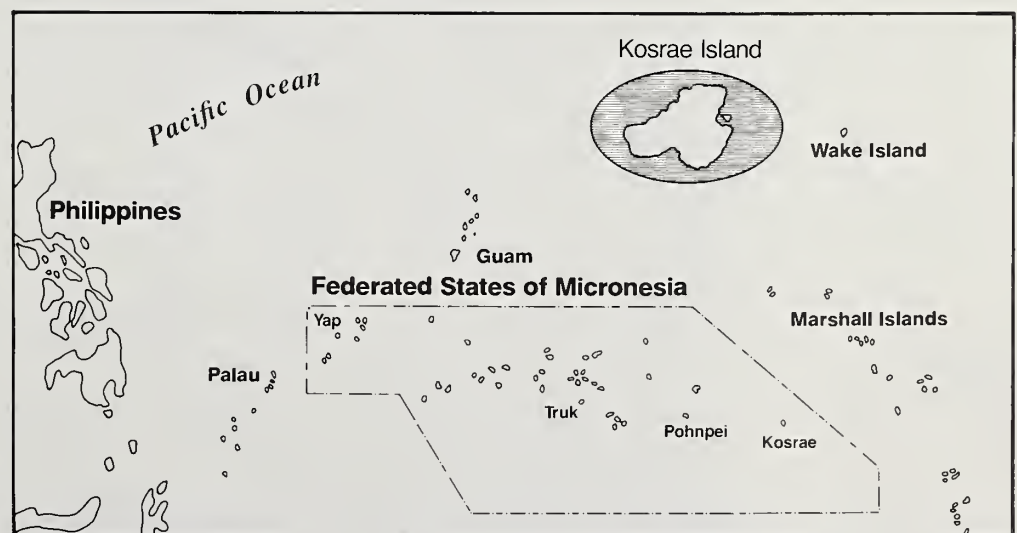


Figure 1—Kosrae, Federated States of Micronesia, is located at the eastern end of the Caroline Island group.

Table 1—Area of Kosrae by land class and type, 1983

Land class and type	Symbol	Area		
		Initial	Adjusted ¹	
<i>Hectares (acres)</i>				
Forest:				
Upland forest	UP	5,860		5,090
Swamp forest	SW	518		345
Mangrove forest	MN	1,562		1,562
Dwarf forest	DF	69		69
Total forest		8,009	(19,790)	7,066 (17,460)
Secondary Vegetation:	SV	1,070	(2,644)	1,272 (3,143)
Agroforest:				
Agroforest	AG	918		1,659
Agroforest with coconuts	CO	926		926
Total agroforest		1,844	(4,557)	2,585 (6,388)
Nonforest:				
Barren	B	2		
Cropland	C	2		
Grasslands	G	17		
Marsh, freshwater	M.F	25		
Urban	U	51		
Urban with agriculture	U/ AG	67		
Water	W	99		
Total nonforest		263	(651)	
Total area		11,186	(27,642)	

¹Adjusted by the proportion of field plots that were mapped on 1975 photos as forest or secondary vegetation but were found to be agroforest in 1983.

SURVEY METHODS

Kosrae's vegetation types were identified and delineated on black and white photographs taken in 1976 at scales of 1:5,000, 1:6,000, and 1:16,000. Since then, some changes have occurred. Updating the photos to account for these recent changes was not possible; however, their magnitude was estimated from ground sampling (*tables 1 and 2*).

Vegetation differences can often be recognized by examining photographs stereoscopically for differences in tone, texture, and image patterns. In some cases, individual plants may be recognized by their distinctive shape. Thus, after comparing photoimagery with ground conditions in the field, a skilled interpreter becomes fairly proficient at recognizing vegetative types on aerial photos. Overall accuracy depends on the scale, age, and quality of the photographs; skill of the interpreter; degree to which the types differ in image characteristics; and the amount of ground training and checking by the interpreter.

Table 2—Area of forest land on Kosrae, by size class and density, 1983

Type	Size class ¹	Density class ²			Total ³
		Low	Medium	High	
<i>Hectares (acres)</i>					
Upland forest	1	0	486	159	645 (1,594)
Upland forest	2	45	2,577	1,823	4,445 (10,984)
Mangrove	1	0	85	423	508 (1,255)
Mangrove	2	0	526	528	1,054 (2,604)
Swamp forest	1	0	27	15	42 (104)
Swamp forest	2	0	159	144	303 (749)
Dwarf forest	0	0	69	0	69 (170)
Total forest					7,066 (17,460)

¹0—Short, shrub-like trees smaller than 12.5 cm (5 in) in d.b.h.

1—Trees averaging less than 30 cm (12 in) in d.b.h. but larger than or equal to 12.5 cm (5 in) in d.b.h.

2—Trees averaging 30 cm or more (>12 inches) in d.b.h.

²Crown closure of main canopy: low <30 pct; medium 30-70 pct; high >70 pct.

³Adjusted by the proportion of field plots that were mapped on 1976 photos as forest but were found to be agroforest in 1983.

Before vegetation typing could begin, a vegetation mapping scheme was needed. Because much of the island is inaccessible by road and funds were limited, vegetation types were restricted to those that could be recognized on the photos without intensive ground checking. In addition, the type characteristics delineated were limited to those useful to foresters and land-use planners.

After considerable field reconnaissance, the classification scheme presented in this bulletin was adopted. Types were delineated on the photos after stereoscopic examination and ground checking along roads and trails. Then the photos were edited and sent to the Engineering Geomtronics Section of the Forest Service's Pacific Southwest Regional Office, for transfer to base maps and measurement of type areas (*tables 1 and 2, figs. 2 and 3*).

TYPE CLASSIFICATIONS

For mapping purposes, the island of Kosrae was divided into four broad land classes—forest, secondary vegetation, agroforest, and nonforest. Primary types under the major land classes include:

Forest—The forest class consists of four types of areas vegetated with live trees:

- Upland forest (UP)
- Swamp forest (SW)
- Mangrove forest (MN)
- Dwarf forest (DF)

Secondary vegetation (SV)—Secondary vegetation includes vines, shrubs, and small trees on recently disturbed areas.

Agroforest (AG)—The agroforest class is made up of areas under cultivation for both fruit and other food crops, and trees and wood products.

Nonforest—Nonforest areas consist of lands which have never supported forests or are currently developed for non-forest uses:

- Marsh (M)
- Grassland (G)
- Cropland (C)
- Urban (U)
- Barren (B)
- Water (W)

The forest types have been further subdivided into size and density classes (*table 2*), identified by these codes:

Code	Size class
0	Short, shrub-like stands smaller than 12.5 cm (5 inches) in diameter at breast height (d.b.h.).
1	Trees averaging less than 30 cm (12 inches) in d.b.h. but larger than or equal to 12.5 cm (5 inches) in d.b.h.
2	Trees averaging 30 cm (12 inches) or more in d.b.h.

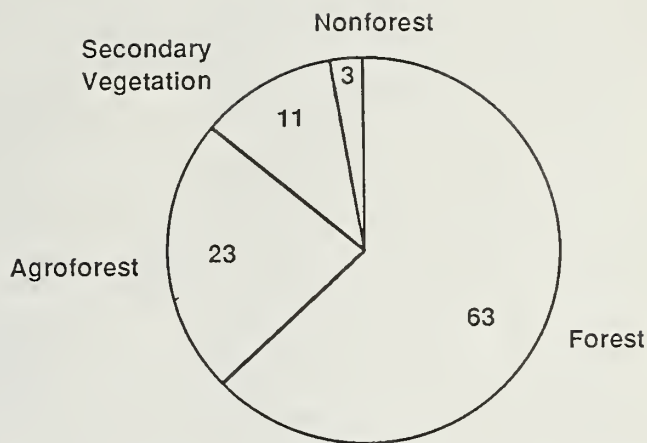


Figure 2—Percentage of land area in the four major land classes on Kosrae.

Code	Density class
H	High—crown closure of main canopy over 70 percent.
M	Medium—crown closure of main canopy between 30 and 70 percent.
L	Low—crown closure of main canopy less than 30 percent.

On the map, vegetative areas are numbered and identified by symbols in the legend (*table 3*). In each symbol, the vegetation type is shown first, followed by the size class and density class. For example, MN1H would indicate mangrove trees that are less than 30 cm (12 inches) but at least 12.5 cm (5 inches) in diameter, with a crown closure greater than 70 percent. Where possible, predominant species are identified. In such cases, the density class is followed by a period, then by the first letter of the genus name, as in MN1H.S when *Sonneratia alba* makes up at least 20 percent of the mangrove stand. Occasionally, two-storied stands are identified by a slash between the overstory and understory classes, with size and density classes given only for the overstory type. For example, UP2L/SV.H would indicate an overstory composed of scattered trees of upland species overtopping secondary vegetation with a *Hibiscus tiliaceus* component.

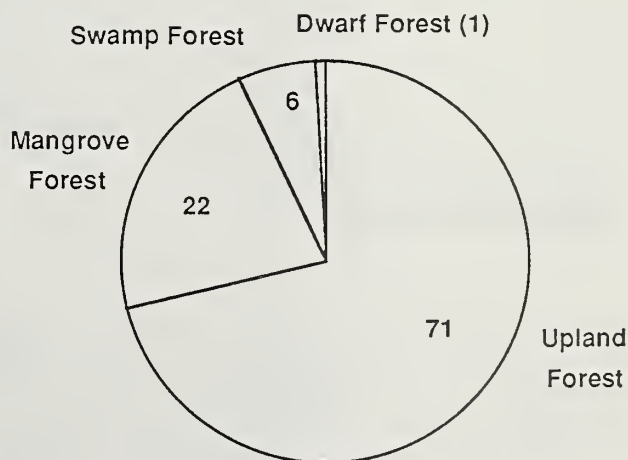


Figure 3—Percentage of land area in the major forest types on Kosrae.

Table 3—Vegetation type codes used for Kosrae, Federated States of Micronesia¹

Land class	Vegetation codes	Vegetation types, subtypes and components
Forest	UP	Upland forest, various size and density classes apply
	UP/SV	Secondary vegetation understory
	SW	Swamp forest, various size and density classes apply
	SW.B	<i>Barringtonia</i> component
	SW.T	<i>Terminalia</i> component
	SW/SV.H	<i>Hibiscus</i> understory
	SW/SV.BB	Bamboo understory
	SW.T/SV.BB	<i>Terminalia</i> component and <i>Pandanus</i> understory
	MN	Mangrove forest, various size and density classes apply
	MN.N	<i>Nypa</i> palm component
	MN.S	<i>Sonneratia</i> component
	MN.R	<i>Rhizophora</i> component
	DF	Dwarf or moss forest, various size and density classes apply
Secondary vegetation	SV	Secondary vegetation, size and density classes do not apply
	SV.H	<i>Hibiscus</i> component
	SV.S	Shrub component
Agroforest	AG	Agroforest
	AG.CO	Coconut component
	AG/M.F	Freshwater marsh understory
Nonforest	M	Marsh
	M.F.C	Freshwater cultivated marsh
	M.F.P	Freshwater <i>Phragmites</i> marsh
	G	Grassland
	G.B	Barren component
	G.G	Grass component
	G.S	Shrub component
	C	Open cultivation
	U	Urban land
	U/C	Cropland inclusions
	B	Barren
	B.D	Disturbed land
	W	Water, includes fresh, saline, and bays

NOTES:

Size classes and density codes are used only with the forest class and with the coconut plantation type.

All components, inclusions, or understory species must be present on at least 20 percent of the mapped area.

VEGETATION TYPE DESCRIPTIONS

A detailed description of the vegetation types is listed below. Classes are described by habitat and major overstory and understory species. Scientific names of dicotyledonae follow those by Fosberg and others (1979). Palm nomenclature follows that of Moore and Fosberg (1956). A partial list of Kosraean plants is presented in *table 4*.

Forest

Upland Forest (UP)

The steep slopes of Kosrae are covered with well-developed native rain forest, with a number of natural plant associations occurring at different elevations. These forests protect the watersheds, hold the soil, and provide habitat for wildlife. They also provide building materials, medicine, and recreation for people. The forests of Kosrae harbor a number of plants and animals which should be protected as they are found nowhere else in the world.

Table 4—Partial list of Kosraean plant species

Genus	Species	Author	Family
Adenanthera	pavonina	L.	Mimosaceae
Angiopteris	evecta	(Forst.) Hoffm.	Marattiaceae
Artocarpus	altilis	(Park) Fosb.	Moraceae
Asplenium	nidus	L.	Polypodiaceae
Astronidium	kusaianum	Kaneh.	Melastomaceae
Barringtonia	racemosa	(L.) Spreng.	Lecythidaceae
Bruguiera	gymnorhiza	(L.) Lam.	Rhizophoraceae
Camptosperma	brevipetiolata	Volk.	Anacardiaceae
Cananga	odorata	(Lam.) Hook. f. & Thoms.	Annonaceae
Citrus	spp.	L.	Rutaceae
Clerodendrum	inermis	(L.) Gaertn.	Verbenaceae
Cocos	nucifera	L.	Palmae
Costus	sericeus	Bl., Enum.	Zingiberaceae
Curcuma	spp.	L.	Zingiberaceae
Cyathea	spp.	J. E. Smith	Cyatheaceae
Cyclosorus	heterocarpus	Ching	Aspidiaceae
Dendrobium	carolinense	Schltr.	Orchidaceae
Derris	elliptica	(Roxb.) Benth.	Fabaceae
Elaeocarpus	carolinensis	Koidz.	Tiliaceae
Elaphoglossum	carolinense	Hosok.	Polypodiaceae
Eugenia	stelechantoides	Kaneh.	Myrtaceae
Ficus	spp.	L.	Moraceae
Flagellaria	indica	L., Sp.	Flagellariaceae
Freycinetia	ponapensis	Martelli	Pandanaceae
Gleichenia	linearis	(Burm.F.) C.B.Cl.	Gleicheniaceae
Gonocormus	minutus	(Bl.) v.d.B., Hym.	Hymenophyllaceae
Hibiscus	tiliaceus	L.	Malvaceae
Horsfieldia	nunu	Kaneh.	Myristicaceae
Inorcarpus	fagifera	(Park) Fosb.	Fabaceae
Ixora	casei	Hance, Walp.	Rubiaceae
Lindsaea	rigida	J. Sm., Hook.	Polypodiaceae
Ludwigia	spp.	L.	Onagraceae
Mangifera	indica	L.	Anacardiaceae
Manihot	esculenta	Crantz, Inst.	Euphorbiaceae
Marattia	fraxinea	J. E. Sm., Pl.	Marattiaceae
Mecodium	polyanthos	(Sw.) Copel.	Hymenophyllaceae
Meringium	holochilum	(v.d.B.) Copel.	Hymenophyllaceae
Merremia	peltata	(L.) Merr.	Convolvulaceae
Musa	spp.	L.	Musaceae
Nephrolepis	hirsutula	(Forst.) Presl.	Davalliaceae
Neubergia	celebica	(Koord.) Leenh.	Loganiaceae
Nypa	fruticans	Wurmb	Palmae
Pandanus	spp.	Stickman	Pandanaceae
Parinarium	laurina	Gray	Chrysobalanaceae
Peperomia	kusiaensis	Hosok.	Piperaceae
Phragmites	karka	(Retz.) Trin. ex Steud.	Gramineae
Phreatia	pacifica	Fukuyama	Orchidaceae
Piper	ponapense	C.DC.	Piperaceae
Pleuromanes	pallidum	(Bl.) Presl.	Hymenophyllaceae
Polyscias	subcapitata	Kaneh.	Araliaceae
Premna	obtusifolia	R. Brown	Verbenaceae
Prosaptia	serraeformis	(Bl.) Christ.	Polypodiaceae
Psidium	guajava	L.	Myrtaceae
Pteris	spinescens	Presl.	Polypodiaceae
Ptychosperma	ledermanniana	(Becc.) Moore & Fosb.	Palmae
Rhizophora	apiculata	Bl.	Rhizophoraceae
Rhizophora	mucronata	Lam.	Rhizophoraceae
Rubrus	moluccanus	L.	Rosaceae
Scirpodendron	ghaeri	(Gaertn.) Merr.	Cyperaceae
Sonneratia	alba	J.E. Smith	Sonneratiaceae
Terminalia	catappa	L.	Combretaceae
Terminalia	carolinensis	Kaneh.	Combretaceae
Vittaria	elongata	Sw., Syn.	Polypodiaceae
Wollastonia	biflora	(L.) DC.	Compositae
Xylocarpus	granatum	Koen.	Meliaceae
Zingiber	zerumbet	(L.) Smith	Zingiberaceae

At lower elevations, upland forest is a mix of *Campnosperma brevipetiolata*, tall *Horsfieldia nunu*, and other codominate species—including *Adenanthera pavonina*, *Elaeocarpus carolinensis*, *Ficus* spp., *Neubergia celebica*, *Eugenia stelechantha*, and thickets of *Parinarium laurina* and *Hibiscus tiliaceus*. Species commonly found in the understory include the tall fern *Angiopteris evecta*, *Ixora casei*, *Polyscias subcapitata*, *Cyathea* spp., *Cyclosorus heterocarpus*; the lianas *Freyenetia ponapensis* and *Flagellaria indica*; and the vines *Derris elliptica* and *Piper ponapense*. Many terrestrial and epiphytic ferns are present. Common herbs include *Zingiber zerumbet*, *Costus sericeus*, and *Curcuma* spp.

At higher elevations, *Campnosperma* is more commonly found in association with *Elaeocarpus*, *Eugenia stelechanthoides*, the palm *Ptychosperma ledermanniana* (syn. *Ponapea kusaensis*), and other species.

Swamp Forest (SW)

Swamp forest occurs where soils are inundated with fresh or brackish water. The most common habitat for such forests is in low, wet areas just inland of mangroves, usually above tidal influences but lower in elevation than the surrounding terrain. Other habitats are inland where water collects in low areas along rivers and in areas of impeded drainage.

Broad river valleys and alluvial fans, especially in Tafunsak Municipality, are vegetated with tall *Terminalia carolinensis* trees, whose flat canopy presents a distinct texture on the aerial photographs. These wide-buttressed, magnificent trees grow 20 to 30 m (66 to 100 ft) in height. Other trees present include *Horsfieldia nunu*, *Barringtonia racemosa*, *Hibiscus tiliaceus*, *Nypa fruticans*, and *Neubergia celebica* (Hosokawa 1954). *Pandanus* spp. is also a common understory species, which may, when extremely dense, prevent the natural regeneration of the valuable *Terminalia*. *Scirpodendron ghaeri* and *Cyclosorus heterocarpus* also are found in the swamp forest, and the habitat is rich in epiphytes including *Nephrolepis hirsutula*, *Dendrobium carolinense*, *Gonocormus minutus*, *Asplenium nidus*, and *Vittaria elongata*.

Mangrove Forest (MN)

In mangrove forests, tree roots are periodically inundated with sea water. They serve as a natural filtering and nutrient buffering system between the island and lagoon, settling silt and providing for a slow sustained release of nutrients. Mangroves also serve as fish nurseries and habitat for birds and fruit bats; and provide people with building materials, firewood, and fishing and gathering grounds.

The mangrove type is quite distinct on aerial photos due to the texture produced by the rounded clumps of trees, usually bounded on one side by water. The inner margin of mangroves is sometimes hard to discern as it intergrades with swamp forest and other vegetation.

The mangroves of Kosrae differ from those of other Caroline Islands in occurring behind a protective strip of coastal strand vegetation (Stemmerman and Proby 1978). Interestingly, this vegetation is growing on a sandy rampart which has been built upon the fringing reef, similar to an atoll

formation. This fringing, sandy strand protects the interior mangroves from direct ocean waves and currents. This strand occurs on the northeastern and southern coasts of Kosrae. Mangroves are coastal only on the northwestern coast in Tafunsak Municipality and in the protected bays of Lelu to the east and Utwa to the south.

The major species found in Kosraean mangroves is *Sonneratia alba*, some individuals attaining heights of 25 to 30 m (80 to 100 ft) with diameters of 1.5 m (60 inches). *Sonneratia* grows especially large on the remote northwest coast. *Rhizophora mucronata* is usually found at the mouths of rivers and channels, with *R. apiculata* and *Bruguiera gymnorhiza* common, along with *Sonneratia*, toward the interior of the mangrove. Numerous small patches of *Nypa fruticans* and *Xylocarpus granatum* occur toward the landward edge of the mangrove.

Dwarf Forest (DF)

Moss forests of Kosrae and nearby Pohnpei Island occur at much lower elevations than moss forests in other parts of the world (Hosokawa 1952). These scrubby, wet moss or dwarf forests occur in the cloud zone of mountain tops and ridges. Such forests consist of stunted trees covered with epiphytic bryophytes, ferns, fern allies, and orchids. The understory and ground are covered with similar growth. These forests contain many different native species.

Species found in the moss forests of Kosrae include an upper layer of scattered stunted trees, including *Elaeocarpus carolinensis*, *Cyathea* spp., and *Astronidium kusaianum*. Lower layers include *Polyscias subcapitata* and *Eugenia stelechantha*. Undergrowth includes *Marattia fraxinea* and *Pteris spinescens*. Vascular epiphytes include *Elaphoglossum carolinense*, *Phreatia pacifica*, *Prosaptia serraeformis*, *Pleuromanes pallidum*, *Mecodium polyanthos*, *Lindsaea rigida*, *Meringium holochilum*, and *Peperomia kusaensis*.

Moss forests tend to be more common and better developed on the leeward sides of the highest mountains. The more exposed ridges on the east side of the island seem to be dominated more by the fern *Gleichenia linearis* (Maxwell 1982). The Kosraean moss forests are of considerable scientific interest and ecological importance because of their uniqueness and limited extent.

Secondary Vegetation

Areas of small weedy trees, scrub, vines, and grasses growing in recently disturbed areas are classified as secondary vegetation. Such areas sometimes represent traditional garden areas left fallow. To some extent they function as a natural "bandage" protecting disturbed soils from Kosrae's heavy rains, allowing humus and nutrients to accumulate in the soils.

The woody secondary vegetation of Kosrae is notable in often consisting of almost pure stands of *Hibiscus tiliaceus*. This low tangled scrubby tree, useful for its fiber, grows in a variety of conditions from swampy areas to hillsides. It is the

principal woody species revegetating abandoned agricultural areas and other disturbed areas such as landslides.

Kosrae has less weedy vegetation than the islands of Pohnpei, Truk, and Yap. The most extensive species is possibly the aggressive vine *Merremia peltata*. *Premna obtusifolia*, *Ludwigia* spp., *Clerodendrum inerme*, and *Wollastonia bibflora* are also common. Cassava (*Manihot esculenta*), which is normally a cultivated food plant, grows wild in grassy areas. The wild raspberry (*Rubus moluccanus*) grows among the weedy vegetation of open areas in the Kapluh plateau forest.

Agroforest

Agroforests occupy areas generally along the coast and near dwellings and are characterized by a mix of food-producing trees and other plants, including coconut, breadfruit, banana, and citrus. These “tree gardens” represent a sustainable system of food production and wise use of limited resources. The canopy is often uneven and may be interspersed with small taro patches, open canopy gardens, and areas of secondary vegetation too small to be mapped as separate types.

Common agroforest trees on Kosrae are breadfruit (*Artocarpus altilis*), coconuts (*Cocos nucifera*), bananas (*Musa* spp.), mangoes (*Mangifera indica*), guava (*Psidium guajava*), *Inocarpus fagifera*, *Terminalia catappa*, and *Cananga odorata*. The island of Kosrae is especially noted for its limes, oranges, and tangerines (*Citrus* spp.), which are exported.

Nonforest

Marsh, Freshwater (M.F)

Areas dominated by grasses, sedges, and herbaceous growth that grow in standing freshwater most of the year are classified as marshes. Two subtypes of freshwater marshes are delineated:

- Tall reeds, usually *Phragmites karka* (designated M.F.P)
- Cultivated marshes, usually taro (designated M.F.C)

Grassland (G)

Grasslands or “savanna” are areas of land supporting a layer of low herbaceous cover. Shrubs and trees, if present, are widely scattered. The soils are generally infertile poorly drained clays. The savanna grassland areas are thought to be the result of destruction of the forest vegetation, particularly by fire which removes the humus layer and exposes the soil to the eroding effects of wind, sun, and rain. Frequent fires prevent tree species from returning, and as the soil becomes more and more degraded, fewer and fewer species survive. Kosrae has the least amount of grassland vegetation of the Micronesian nations. Only 17 ha (42 acres) of this type were mapped.

Three subtypes of grasslands were included in the survey:

- Areas of patchy herbaceous growth—generally low grasses and sedges—on degraded sites, where patches of bare

soil are common (designated G.B).

- Open areas with predominantly grass or grass-like ground cover (designated G.G).
- Grasslands with a mixture of grasses and shrubs (designated G.S).

Cropland (C)

Cropland is cultivated land that lacks tree cover. Most Kosraean gardens are too small to delineate, and are often included with other types such as agroforest or secondary vegetation.

Urban (U)

Towns, villages, and areas developed for nonforest use. Where buildings, roads, etc. are interspersed with cropland, the area is classed as urban/cropland (U/C).

Barren (B)

Disturbed areas that lack natural vegetation because of rocks, sterile soil, bulldozing, etc. are delineated as barren.

Water (W)

Includes fresh, saline, and saltwater bays.

GLOSSARY

Agroforest: An area where timber trees, planted fruit trees, and other agricultural plants are cultured.

D.b.h.: Diameter at breast height. Tree diameter outside bark measured at breast height, 1.3 m (4.5 ft) above the ground.

Forest land: Land at least 10 percent stocked by live trees or land formerly having such tree cover and not currently developed for nonforest use.

Land area: Land area includes dry land and land temporarily or partially covered by water, such as marshes, swamps, and river floodplains; streams and sloughs.

Land class: A classification of land by major use or major vegetative characteristics.

Nonforest land: Land that has never supported forests or was formerly forested and is currently developed for nonforest use.

Secondary vegetation: A vegetative type characterized by small fast-growing trees. Vines are sometimes present.

Vegetative types: Areas delineated on the maps as having similar plant composition to one of the types described in the section on type classification.

REFERENCES

- Fosberg, F. R.; Sachet, Marie-Helene; Oliver, Royce. A **geographical checklist of the Micronesian Dicotyledonae**. *Micronesica* 15(1-2): 41-295; 1979.
- Hosokawa, Takashide. A **synchrological study of the swamp forests in the Micronesian Islands**. Mem. Fac. Sci., Kyushu Univ. Ser. E. 1: 101-123; 1952.
- Hosokawa, Takashide. **On the *Camptosperma* forests of Yap, Ponape, and Kusaie in Micronesia**. Mem. Fac. Sci., Kyushu Univ. Ser. E. 1: 129-243; 1954.
- Laird, William E. **Soil survey of island of Kosrae, Federated States of Micronesia**. Honolulu, Hawaii: Soil Conservation Service, U.S. Department of Agriculture; 1983. 67 p. and maps.
- Maxwell, Bruce D. **Floristic description of native upland forests on Kosrae, Eastern Caroline Islands**. *Micronesica* 18(2): 109-120; 1982.
- Moore, Harold E.; Fosberg, F. Raymond. **The palms of Micronesia and the Bonin Islands**. *Genetes Herbarium* 8(6): 423-478; 1956.
- Stemmerman, Lani; Proby, Fred. **Inventory of wetland vegetation in the Caroline Islands, volume I**. Honolulu, HI: Pacific Ocean Division, U.S. Army Corps of Engineers; 1978. 231 p.



The Forest Service, U.S. Department of Agriculture, is responsible for Federal leadership in forestry. It carries out this role through four main activities:

- Protection and management of resources on 191 million acres of National Forest System lands.
- Cooperation with State and local governments, forest industries, and private landowners to help protect and manage non-Federal forest and associated range and watershed lands.
- Participation with other agencies in human resource and community assistance programs to improve living conditions in rural areas.
- Research on all aspects of forestry, rangeland management, and forest resources utilization.

The Pacific Southwest Forest and Range Experiment Station

- Represents the research branch of the Forest Service in California, Hawaii, and the western Pacific.
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Whitesell, Craig D.; MacLean, Colin D.; Falanruw, Marjorie C.; Cole, Thomas G.; Ambacher, Alan H. **Vegetation survey of Kosrae, Federated States of Micronesia.** Resour. Bull. PSW-17. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 1986. 8 p. + map.

The vegetation of Kosrae, Federated States of Micronesia, in the eastern Caroline Islands was mapped for use in land-use planning, forest resource management, and timber volume surveys. The map shows the location and extent of vegetation types identified from 1976 aerial photographs. A 1983 ground survey identified changes in land-use since 1976. Adjusted forest area is estimated at 7066 ha (17,460 acres), with an additional 1272 ha (3143 acres) in secondary vegetation. Twenty-three percent (2568 ha or 6388 acres) of the island is used for agroforestry.

Retrieval Terms: vegetation survey, vegetation maps, forest types, Kosrae, Federated States of Micronesia, Caroline Islands, Micronesia